EARTH DAY

20 Years Later

Search for Answers to Cli

By Simson L. Garfinkel
Staff writer of The Christian Science Monitor
BOSTON

WHEN the Du Pont Company announced it was shutting down its plants that make ozone-destroying chloroflurocarbons (CFCs), countries around the world started calling, asking to buy them.

"Since we announced this total phaseout of CFCs, we have had number of inquires from developing countries that account for 60 to 70 percent of the world's population to buy our plants or to buy CFC technology," says Leo E. Manzer, a research manager at Du Pont, the world's largest producer of CFCs.

Du Pont refused to sell the plants, giving as its reason that CFCs made in developing countries are as bad for the Earth's ozone shield as CFCs made in the United States.

The Du Pont action followed an international agreement three years ago, when 23 industrialized countries gathered in Montreal and promised to cut their production of CFCs by the year 1999. "Five [CFC] plants have started up since the treaty was signed in 1987," Dr. Manzer says.

In his laboratory at the University of California at Irvine, F. Sherwood Rowland, an atmospheric chemist, analyzes samples of air from all over the world. He has found industrial chemicals like CFC-113, used almost exclusively in the electronics industry, in places as remote as Barrow, Alaska. "There is no place in the world that people live that is free of this pollution," Dr. Rowland says.

Unlike smog or radiation, CFCs do not pose a direct threat to human health. The chemicals, which are used as propellents in aerosol-spray cans, to blow foam, and in refrigerators, eventually escape into the atmosphere where they contribute to global warming and break down the ozone layer that shields the surface of the Earth from the sun's deadly ultraviolet radiation. "When they stop becoming a greenhouse problem, they start becoming an ozone problem," says Donald Blake, a postdoctoral research assistant in Rowland's laboratory.

Sixteen years ago, Rowland and Mario Molina published an article in the journal Nature, hypothesizing that CFCs might damage ozone in the upper atmosphere. Although Rowland and Dr. Molina lacked proof of actual ozone destruction, their argument was convincing enough that the United States, Canada, Sweden, and Norway banned the use of CFCs in most aerosol-spray cans.

In 1985, Dr. John Farman, a scientist for the British Survey, published a paper in Nature that said the ozone over the Halley Bay Station had been decreasing since 1957. Two years later, a modified U-2 spy plane flying over the Antarctic confirmed the ozone hole. Experiments proved that chlorine released by CFCs was the culprit.

Companies like Du Pont are now hurriedly searching for ways of making CFC alternatives. But with $135 billion of equipment that uses CFCs in the United States alone, Manzer says, replacements must match the physical properties of the CFCs closely. If a replacement gas expands more when heated than does CFC-12, commonly used in automobile air conditioners, it might blow pressure-relief valves in cars on a hot day, he says.

A second problem with the alternatives is their price: Because the substitute chemicals require three or four steps to manufacture, instead of the single step for most CFCs, they will probably cost three to five times as much. That cost will be especially difficult for developing countries – the countries now seeking to buy or build Du Pont's cheaper CFC technology.

Scientists say the problems and issues raised by the ozone layer are just a taste of what awaits the world on an even larger climatological problem: global warming.

The global greenhouse

The Earth's atmosphere acts like the glass in a greenhouse. Visible light from the sun passes through the atmosphere and heats the Earth's surface. But trace gases in the atmosphere, mostly carbon dioxide and water vapor, trap infrared radiation emitted from the surface and keep it from being reflected back into space.

"If we had no atmosphere, the temperature of the Earth would be around 0 degrees F.," says Blake. "Because of carbon dioxide, water vapor, and ozone, we have an average temperature of about 60 degrees F."

Those trace gases have been steadily increasing since the Industrial Revolution began in the 18th century. Carbon dioxide (CO_2) is on the rise thanks to the burning of coal, oil, and natural gas. Methane, another greenhouse gas, is on the rise because of increased agriculture. For developing countries, limits on greenhouse gas production – essentially bans on development – might be even more unacceptable than limits on CFCs.

A hundred years ago, the concentration of CO_2 in the Earth's atmosphere was roughly 280 parts per million (ppm). Today, carbon dioxide is at 340 ppm and rising.

In 1896, the Swedish chemist Svante Arrhenius predicted that doubling the amount of carbon dioxide would eventually lead to a 9 degree increase in the Earth's temperature. Most of today's computer-based climatological models forecast a 4 to 9 degree increase in global temperature, "depending on how you represent the clouds," Peter Stone says, an atmospheric scientist at the Massachusetts Institute of Technology (MIT) in Cambridge, Mass.

Although some scientists say it may be years before increased greenhouse gases affect the Earth's temperature, the planet does seem to be getting warmer already. According to James Hansen, director of the NASA-Goddard Institute for Space Studies in New York, 1988 "tied with 1981 as the warmest year on our record." The

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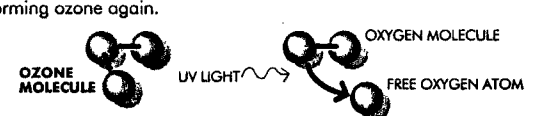
'We can't change the concentration of these gases in the atmosphere without having a consequence on the climate. The fact that we can't predict what that climate is going to be doesn't mean that it won't happen. We can't predict earthquakes, but we know that they happen.'

– F. Sherwood Rowland, atmospheric chemist

Ozone and CFCs

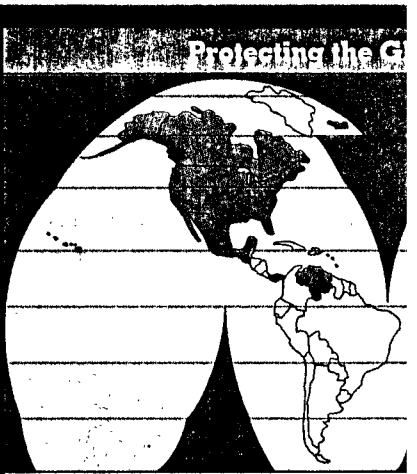
Although scientists speak of an 'ozone layer,' the gas is actually only a tiny fraction of the gases in the atmosphere. Nevertheless, it is an effective shield against the sun's ultraviolet (UV) rays. Here's how CFCs destroy ozone in the upper atmosphere:

1 Under normal bombardment by UV light, ozone molecules continually split into an oxygen molecule and a free oxygen atom. The oxygen atom eventually attaches itself to another oxygen molecule, forming ozone again.



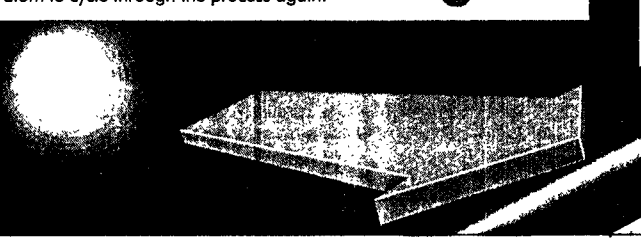
2 Like ozone, CFCs are also split by UV light, releasing a free chlorine atom, which can pull an ozone molecule apart to form regular oxygen gas and chlorine monoxide.

3 The new chlorine monoxide molecule can recombine with a free oxygen atom, freeing the chlorine atom to cycle through the process again.



■ Signers of the 1987 Montreal Protocol li
□ Non-signers and nonparticipants
CFC production plants brought on-line since t
CFC plants under construction, or countries pu
China is reportedly investigating the feasibility

The upper atmosphere is usually taken to include the gaseous envelope from about 19 miles upward.



) Climate Warming Heats Up

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global average temperature for those two years was 0.63 degrees F. above the world's average between 1950 and 1980. Last year "was warm, but it was not as warm as the previous year. . . . I think it was the sixth or seventh."

Last year would have been warmer, Dr. Hansen says, except for a "periodic up-swelling of cold water in the eastern Pacific," called the El Niño, that has been keeping temperature in that ocean cool. "As we come out of that cool phase, we are going to get hotter temperatures in the next year or two which may rival or exceed the hottest years in the 1980s."

But predicting the actual amount of warming – and how soon it will take place – is difficult, says Kerry Emmanuel, chairman of MIT's Department of Earth and Planetary Sciences and a critic of many global climate models.

Models of Earth's climate

Scientists lack a comprehensive theory, or "analytic understanding," of how the Earth's climate actually works. "One would hope that we would at least have an analytic understanding of some of the subprocesses, an understanding that is rooted in the physics of the phonemena," Dr. Emmanuel says. Even detailed understandings of the convection of air or the circulation of the oceans remain beyond the grasp of climatologists.

That understanding is vital, Emmanuel says, because "water vapor is a much more important greenhouse gas than CO_2." Like carbon dioxide, water vapor traps in the heat from the ground, but "there is a lot more of it."

Clouds move water around the globe. Since they can't be modeled directly, their effects must be inferred from other variables – which is where Kerry and other scientists say that the models get shaky.

"There may be powerful negative feedback so strong that the amount of extra warmth is so small [as not to matter]," he says. "If you increase the amount of clouds by just a few percent, you could offset the warming. Clouds reflect sun back to space: They're white."

Nevertheless, many scientists say the possibility for global warming should be reckoned with now. "The numbers, to me, are worrisome, even given all of the uncertainties in the models," MIT's Dr. Stone says.

"One of the things that we really need to do is to improve our understanding of some of these processes that are important," he says. "That requires getting lots of data."

For example, Stone says, detailed measurements have to be made to determine the temperature of the ocean at different depths. One proposed experiment involves conducting underwater detonations and measuring the time it takes for the sound to travel to different parts of the world: Because cold water is denser than warm water, sound travels slower through it.

"This would be very valuable to tell us if we are getting a true global warming, and to tell us how rapidly it is coming about. The faster [the heat] penetrates into the deep oceans, the longer it will take" to warm up the surface, Stone says. "It is an important difference if we get a rise in 10 years or in a hundred, and that is the kind of uncertainty there is."

But few scientists doubt that a warming is coming. "The fact that the atmosphere is changing, that much is certain," Rowland says. "Carbon dioxide is going up. Methane is going up. Those [trends] aren't questioned any more."

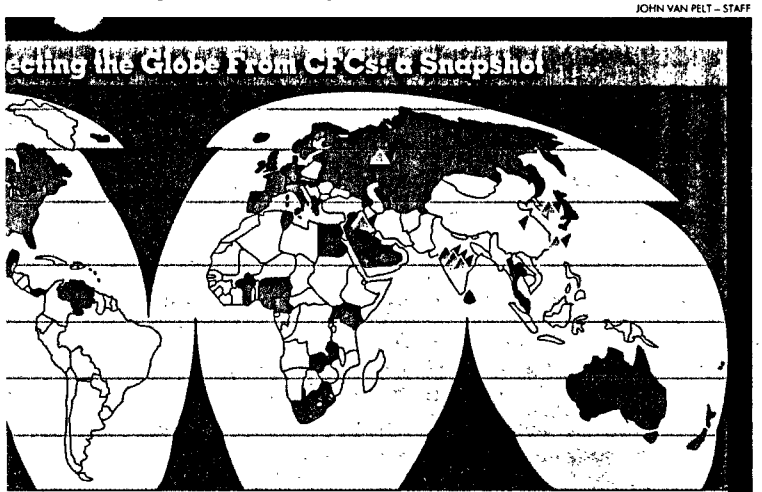
"You hear a lot of people say, 'I'm not sure that the greenhouse effect is real.' It is very real, in that there are driving forces: We can't change the concentration of these gases in the atmosphere without having a consequence on the climate," he says. "The fact that we can't predict what that climate is going to be doesn't mean that it won't happen. We can't predict earthquakes, but we know that they happen."

One of the most important developments in recent years has been the political agreement to cut the use of CFCs, Stone says: "If nothing were done about CFCs, they would become the worst part of the warming problem in 20 years time."

"The laws that were passed in the US and other countries [in the 1970s] did have a beneficial effect. The [warming] effect in recent years has not been as bad as it would have been if those laws had not been passed." That's because each CFC molecule traps more than a thousand times as much heat as each molecule of carbon dioxide.

One pressing problem, Stone says, is a shortage of scientists in the field of meteorology, a field that has perhaps fewer than 2,000 people engaged in research. "A lot of this money that they are talking [about] spending in [NASA's proposed] Earth Observation System will gather data, but we don't have the manpower to make use of it. So we are going to need money for increasing the supply of scientists working on these problems."

JOHN VAN PELT – STAFF



Mission to Planet Earth Takes Off

By Robert C. Cowen
Staff writer of The Christian Science Monitor

BOSTON

SEEING ourselves from the perspective of space can be shocking.

For example, about 180 experts attending the first biomass burning conference last month in Williamsburg, Va., said they had underestimated the fire threat. Astronauts' photos showed that annual burning of forest and savanna in Africa (see Page 12) and the Amazon basin has risen 10-fold since 1973. Humans torch about 5 percent of Earth's surface every year. Carbon dioxide and other gases generated are major contributors to greenhouse warming.

The realization that we simply do not know what we are doing to our planet has put Mission to Planet Earth at the top of the world's environmental science agenda. This is a set of national and international programs that combine space-based scrutiny with extensive surveys on land and sea. Over the next two decades, these should enable scientists to assess the state of the Earth.

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Mission to Planet Earth actually means several things at once. Nations working through the International Council of Scientific Unions know it as the International Geosphere/Biosphere Program whose goal is to understand the interrelation of the planet with its living community, from bacteria to people.

For the 60 scientists from about 14 countries who met in Bad Ischl, Austria, in February, it means 10 projects due in time for the 1992 International Space Year. They include, for example, a joint Brazilian and European Community effort to estimate deforestation rates and to map deforestation from 1983 to 1991.

West Germany and the US National Aeronautics and Space Administration (NASA) will lead studies to learn what's happening to polar zones.

Canada and the United States are leading a project to make the most of available satellite data to produce a Global Change Encyclopedia of climate and atmospheric changes. Austria then will lead the work to translate the encyclopedia into a 300-page atlas to be ready by spring 1992.

For NASA, Mission to Earth is a plan for satellite-based Earth observing that extends well into the next century. It starts with planned and existing satellites in the early 1990s and matures into several large polar-orbiting instrumented platforms – the Earth Observing System – to be launched starting in 1998.

This is a significant part of the Bush administration's Global Change Research Program. The program involves six agencies besides NASA and includes studies both from orbit and on the surface. According to presidential science advisor D. Allan Bromley, "This approach has, as its central goal, the provision of a sound scientific basis for developing national and international policy on global change."